

Impact of the liberalisation of the electricity market

an analysis with MARKAL Belgium

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Questions and approach

- Questions:
 - impact of trade on the electricity price and on the choice of technologies
 - impact of trade on the environmental conditions/constraints, e.g. Kyoto target
- Analysis with MARKAL/TIMES Belgium extended with the electricity sector in the neighbouring countries



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Characteristics of MARKAL/TIMES Belgium for the study

- Multi region model with
 - the Belgian model covering the whole energy system with supply and demand of all sectors
 - the model for France, the Netherlands and Germany covering only the electricity sector
 - the country models are interlinked through transmission lines
- Investment in transmission capacity is allowed with a cost increasing with distance
- The cost for new power plants are assumed to be similar in all countries
- Countries differ in terms of installed capacity: nuclear is dominant technology in Belgium and France for electricity production but nuclear phase-out in Belgium from 2020 onwards



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Scenarios analysed with the extended MARKAL/TIMES Belgium

- *'Baseline scenario'* without trade and without environmental constraint
- *'Trade scenario'* where trade is possible between the countries but still no environmental constraint
- *'CO2 scenario'* with and without trade (target is on CO2 though Kyoto target is on GHG)
 - Belgium must satisfy its Kyoto constraint (CO2 reduction of 7.5% in 2008-2012 compared to emissions in 1990)
 - CO2 emission constraints in the electricity sector in the other countries



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Impact of trade on the energy system: the trade scenario

- Impact on the technology mix is small partly because our assumption of no cost differential between countries for new capacity and no cheap source of energy in any of the countries
- It is cost effective to trade electricity in 2010 and 2015 mostly because it allows more flexibility in the investment in new capacity and around these periods installed capacities are beginning to be scrapped.
- Introducing trade decreases slightly the electricity price in Belgium, around 1% for residential use and 2% for industrial use and this increases the electricity demand.
- The price decrease explained by the reduction in the investment cost because trade contributes to the reserve margin



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Impact of trade on the energy system: the trade scenario (2)

- Trade increases the pressure on the environment: higher electricity consumption induces higher production with coal power plants and thus higher CO₂ emissions.
- In terms of economic welfare there is a small increase in the discounted total surplus
- Also as the MARKAL model assumes perfect competition, no gain can be obtained compared to the baseline from reducing the strategic behaviour of the actors on the market.



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Electricity market liberalisation and environmental policy

- For the CO₂ scenario where Belgium has to satisfy its Kyoto constraint three possibilities are considered:
 - '*CO₂ scenario without trade*': the trade is fixed at the level of the '*trade scenario*'
 - '*CO₂ scenario with trade*': trade is allowed but no environmental constraints are imposed on the other countries
 - '*CO₂ scenario with trade and CO₂ constraints on others*'



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The CO₂ scenario without trade

- With the CO₂ constraint and no trade,
 - decrease in the electricity demand
 - shift in the technologies used: STAG plants are replacing the coal power plants; wind power and hydro are becoming more cost efficient but only small contribution because reduced potential in Belgium.



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The CO2 scenario without trade (2)

Electricity production in Belgium with climate policy and without trade
(difference in TJ compared to trade scenario)

	2005	2010	2015	2020	2025	2030
coal	-0.5	0.0	-75.1	-154.3	-300.4	-336.4
nuclear	0.0	0.0	0.0	0.0	0.0	0.0
STAG	33.2	30.4	50.3	61.8	191.5	240.7
gasturbine	-36.5	-30.0	-35.2	0.0	0.0	0.0
hydro	0.0	0.7	0.7	0.7	0.7	0.7
wind	0.0	1.4	14.0	15.6	15.6	15.6
CHP	2.4	-4.3	5.2	18.3	30.3	24.2
other	0.0	-2.6	-1.0	-1.0	-1.0	-1.0
TOTAL	-1.5	-4.4	-41.1	-59.0	-63.4	-56.3



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The CO2 scenario with trade and no CO2 constraints on other

- Allowing for trade is entirely beneficial for Belgium
 - nearly no change in welfare compared to the 'trade scenario'.
 - the welfare increases with 2997.3 million € compared to the CO2 scenario without trade.
- Instead of investing in STAG, wind energy and CHP, the imports are increasing representing respectively 15% and 40% of total electricity consumed in 2010 and 2020.



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The CO2 scenario with trade and no constraints on other (2)

Electricity production in Belgium with climate policy and with trade
(difference in TJ compared to CO2 scenario without trade)

	2005	2010	2015	2020	2025	2030
coal	0.0	0.0	0.0	0.0	0.0	0.0
nuclear	0.0	0.0	0.0	0.0	0.0	0.0
STAG	7.5	-30.9	-28.2	-33.2	-148.8	-185.9
gasturbine	-8.5	4.4	0.6	0.0	0.0	0.0
hydro	0.0	0.0	0.0	0.0	0.0	0.0
wind	0.0	-1.4	-12.6	-14.2	-14.8	-2.2
CHP	0.0	2.5	-7.7	-23.3	-29.5	-20.5
other	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	-1.0	-25.4	-47.9	-70.7	-193.1	-208.6
Export	0.0	-1.3	0.0	0.0	0.0	0.0
Import	0.0	28.6	99.0	132.7	260.7	265.7



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The CO2 scenario with trade and CO2 constraints on others

- With tighter bounds on the other countries the benefit for Belgium is reduced: the consumer/producer surplus is reduced and the marginal abatement cost increases
- Though trade is always beneficial with the scenarios tested, the impact is dependent on the CO2 policy implemented in the other countries.
- STAG and CHP are replacing the imports.



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The CO₂ scenario with trade and CO₂ constraints on others

Change in total discounted surplus (million €) and marginal abatement cost of CO₂ (€/ton) in Belgium

	Discounted surplus	CO ₂ marginal abatement cost				
		2010	2015	2020	2025	2030
No trade	-2997.3	48.6	76.3	88.4	161.0	191.6
With trade and 0% reduction in neighbouring countries	0	38.4	63.4	66.6	77.5	89.5
With trade and 5% reduction	-365.6	39.3	67.4	70.3	81.4	89.8
With trade and 10% reduction	-470.8	40.9	67.4	70.3	84.8	89.8
With trade and 15% reduction	-591.7	39.6	69.9	70.4	88.9	92.5



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Main Results

- Impact of trade alone is small:
 - No shift in technology mix
 - Slight decrease in electricity price
 - The quantity traded remains limited
- Impact of trade associated with carbon constraints
 - depends on the carbon constraints in neighbouring countries



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Conclusion from this study

- Results show that opening the electricity market can be beneficial in terms of welfare though overall impact depends on
 - Supply options and potential in the other countries
 - Environmental constraints
- Caveats
 - perfect foresight, no information cost
 - perfect competition and no strategic behaviour possible
 - no full modelling of the other countries, no trade in environmental permits



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